

# 2007 RESEARCH PROBLEM STATEMENT

**Problem Title:** Synthesis Study and Field Evaluation of In-situ Culvert Rehabilitation in Utah

**No.:** 07.02-4

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**Project Champion:** Tim Ularich, Denis Stuhff, Michael Fazio, Patrick McGann

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

## 1. Briefly describe the problem to be addressed.

As significant number of aging culverts exist in Utah and throughout the country. Slip-lining old culverts with new, smaller culverts, (typically with a smoother pipe wall material), is one of the more economical and practical rehabilitation approaches. Although the practice has been around for a number of years, there appears to be little standardizations, if any, on slip-lining techniques. The types of end treatments associated with slip-lining can influence the hydraulic capacity of the new culvert, particularly under inlet control. The durability of the exposed grout at the end treatment may also be a concern, particularly for end treatments where the grout is tapered. This study would review the slip lining techniques and types of end treatments used in Utah, and inspect existing slip-lined culverts in Utah to evaluate the durability of exposed grouts (freeze-thaw), and look for evidence of changes in scour potential at the culvert exit resulting from higher exit velocities associated with the smaller pipe.

Slip-lined culverts operating under inlet control will likely experience a reduction of flow efficiency (higher head water required for a given flow rate) if improved endtreatments are not utilized. Based on the common end treatments identified in the synthesis study and improved endtreatments identified by the PI's, UDOT personnel, and/or manufacturers, a limited number of standard and improved inlet end treatments will be evaluated in the laboratory (Utah Water Research Laboratory) to determine relative efficiencies.

Additionally, UDOT needs to develop a decision matrix and analysis tool to help designers determine the most appropriate product, installation process and inlet/outlet features. A draft special provision or specification will also help establish a guideline for advertised bid packages.

**2. Strategic Goal:** ☒ Preservation ☒ Operation ☐ Capacity ☐ Safety (check all that apply)

## 3A. List the research objective(s) to be accomplished:

1. Conduct a literature review to summarize the current state of knowledge regarding the use of slip-lining for culvert rehabilitation.
2. Develop an understanding of the culvert slip-lining techniques use in the State of Utah by interviewing contractors and UDOT personnel and making site visits.
3. Based on the results of objectives (1) and (2), identify issues of possible concern regarding the hydraulic capacity and scour concerns near culvert exits. Recommendations will be provide for issues that have already been addressed in the research literature. Future research problem statements will be provided for any issues not addressed in the literature.
4. With the assistance of UDOT personnel, rehabilitated culvert sites in Utah will be identified and visited. Details of the slip-lined culvert condition will be documented, including but not limited to: end treatment geometry; relative size of the new and old culverts; debris, sediment, and scour issues that might be present; and condition of exposed grout. of findings will be provided.
5. Identify cost, benefits, opportunities, and challenges of in-situ culvert rehabilitation.
6. Identify BMP for sustained culvert performance.
7. Identify two culvert rehabilitation systems and field demonstrate them.

**3B. List the major tasks to accomplish the research objective(s):**

**Estimated person-hours:** 3000

1. Literature review.
2. Contractor and UDOT personnel interviews.
3. Develop list of slip-lined culverts to visit and inspect.
4. Inspect existing slip-lined culverts and possibly witness the slip-lining process first hand.
5. Summarize results of tasks 1-4 into a synthesis report (state of knowledge) and a summary of the field sites information. This report would also identify possible deficiencies in the current practice and make recommendations for additional related research as needed.
6. Conduct literature and product review of promising technologies.
7. Identify two technologies for demonstration.
8. Identify two locations for field demonstration.
9. Conduct field rehabilitation using UDOT crews.
10. Document installation.
11. Prepare training video/slide show showing proper installation techniques.
12. Conduct cost/benefit analysis of culvert rehabilitation vs. traditional methods.
13. Prepare written findings report.

**4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B):** \$100,000 -

Additional materials and equipment costs will be paid from UDOT code 1 maintenance funds - Central maintenance can fund some material or development costs through Methods Studies budget

**5. Indicate type of research and/or development project this is**

Large: ☒ Research Project ☐ Development Project  
 Small: ☐ Research Evaluation ☐ Experimental Feature ☒ New Product Evaluation ☒ Tech Transfer Initiative  
☐ Other: \_\_\_\_\_

(A small project is usually less than \$20,000 and shorter than 6 months)

**6. Outline the proposed schedule (when do you need this done, and how will we get there):**

The proposed project schedule is 24 months. The majority of the field work would be done during the Summer period.

**Tasks to be accomplished in 1st 18 months**

- Synthesis report on existing slip-lined culverts completed
- Development of lab test program for slip-lined culvert inlet end treatments
- Conduct literature review and prepare problem census
- identify demonstration locations and arrange for vendor participation
- Install two culvert rehabilitation projects.

**Tasks to be completed in the 18 and 24 month timeframe:**

- Develop decision and cost analysis matrix
- Analyze data and prepare report for UDOT
- Spring 2008 - Implementation of

**7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?**

Because of the research and implementation/training natures of the project, a joint effort between a university (graduate student project) and UDOT is recommended . The research portion of the study will be conducted through the Utah Water Research Laboratory at Utah State University. The implementation and training portion will be coordinated by Lynn Bernhard (UDOT).

**8A. What deliverables would you like to receive at the end of this project?** (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)

A synthesis report that would identify the needs, if any, for standardizing the slip-lining process in Utah, as well as identify the need for additional research, if any, at the State or Federal level regarding, installation, durability, and performance issues of slip-lined culverts.

1. Two culverts rehabilitated.
2. Written BMP for culvert preservation and rehabilitation.
3. Video/Slide show explaining 'How to' of each system tested.
4. Publication of results.

**8B. Describe how this project will be implemented at UDOT.**

The report generated by this study could be used by UDOT to to standardize culvert slip-lining practices in Utah, identify possible deficiencies, and identify additional search need (hydraulic, structural, fish passage, etc.).

1. UDOT system managers can use demonstrated technology to plan rehabilitation of problematic culverts.
2. Results will be shared with all districts and maintenance managers.
3. Present paper or poster session at an Engineering Conference (2008 or 2009).

**8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be.**

Same as 8B.

1. Culvert failure will be avoided
2. Traffic disruption due to cut-and-cover replacements will be reduced
3. Effect culvert life will be extended using a Culvert Life Extension Program (CLEP)
4. Future culvert-related replacement costs will be reduced as total replacement may be avoided

**9. Describe the expected risks and obstacles as well as the strategies to overcome them.**

The primary risk is that the success of this project requires the cooperation of UDOT personnel and private contractors. Because of potential benefit to UDOT, it is assumed that their help will be easily solicited. The cooperation and perhaps a minimal amount of participation on the part of UDOT personnel may be necessary to encourage private contractors to participate by sharing information regarding slip-lining practices. Other than that, minimal risk will be involved.

A major risk is that the rehabilitation will not work. Poor performance will be avoided by careful advance product review.

**10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:**

<u>Name</u>	<u>Organization / Division / Region</u>	<u>Phone</u>	<u>Email</u>
Lynn Bernhard	UDOT Methods Engineer, Maintenance Planning Division	801-964-4597	lynnbernhard@utah.gov
Michael Fazio	UDOT Deputy Director of Research and Innovation	801-957-8595	mfazio@utah.gov
Dennis Stuhff	UDOT Senior Hydraulic Engineer	801-965-4425	dstuhf@utah.gov
AJ Rogers	UDOT Roadway Operations Safety Manager	435-285-2281	ajrogers@uath.gov
Steve Ogden	UDOT Maintenance Engineer, Price District	435-636-1470	sogden@utah.gov
Tim Ularich	UDOT Asst Maintenance Engineer, Region 2	801-887-8761	tularich@utah.gov
Rich Crosland	UDOT Hydraulics Engineer, Region 3	801-227-8056	richardcrosland@utah.gov
Steve Barfuss	Utah State University		barfuss@cc.usu.edu

**10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:**  
AASHTO. NCHRP through AASHTO.

At the 2007 Transportation Research Board (TRB) meeting in Washington DC, three different committees (Hydraulics, Hydrology, and Water Quality; Culverts and Hydraulic Structures; and the Soil and Structure Interaction committees) all express interest in developing a better understanding of slip-lined rehabilitated culverts. The results from a UTRAC study could be used to better identify the future research needs that could be address as an AASHTO approved, NCHRP (National Cooperative Highway Research Program) funded study.

